WE CLAIM:

1   1.   A method for providing data packet congestion control for a data network having

2   a buffer circuit, each data packet comprising a priority, the method comprising the steps of:

3   determining the particular service flow associated with the data packet,

4   detecting a current data packet flow rate through the data network for the particular

5   service flow associated with the data packet;

6   quantizing the data packet flow rate into at least one level;

7   detecting a buffer circuit depth;

8   determining the priority associated with a current data packet; and

9   processing the current packet in response to the current data packet flow rate, the data

10   packet priority, and the current buffer circuit depth.

1   2.   The method of claim 1 wherein the step of detecting a buffer circuit depth

2   includes detecting an instantaneous value for the buffer circuit depth.

1   3.   The method of claim 1 wherein the step of detecting a buffer circuit depth

2   includes detecting an average value for the buffer circuit depth.

1   4.   The method of claim 1 wherein the step of processing includes determining a

2   probability of dropping a data packet using the current data packet flow rate, the data packet

3   priority, and the current buffer circuit depth to access, from a matrix of plots indicating the

4   probability of dropping the data packet, each of the plots within the matrix of plots indicating the

5   packet drop probability as a function of the buffer circuit depth.

1   5. — The method of claim 1 wherein the step of processing includes determining a

2   probability of dropping a data packet using the current data packet flow rate, the data packet

3   priority, and the current buffer circuit depth to access, from a matrix of plots indicating the

4   probability of dropping the data packet, each of the plots within the matrix of plots indicating the

5   packet drop probability as a function of the buffer circuit depth with a plots that have the same

6   shape and parameters as the plots used for Random Early Discard congestion control techniques.

1   6.   The method of claim 1 wherein the step of quantizing includes quantizing the data

2   packet flow rate into four different flow rates.

1   7.   The method of claim 6 wherein the four predetermined flow rates are determined

2   by comparing the service flow's data packet flow rate with a minimum data rate threshold, a

3   maximum data rate threshold, and a mid-level data rate threshold.

1   8.   The method of claim 1 wherein the step of detecting the buffer circuit depth

2   includes determining the percentage of utilized memory within the buffer circuit.

1   9.   The method of claim 1 wherein the step of determining the priority associated

2   with a current data packet includes the step of reading the header of the current data packet to

3   determine the priority.

1   10.   The method of claim 1 wherein the step of determining the particular service flow

2   associated with the data packet includes the step of reading the header of the current data packet

3   to determine the associated service flow.

1 ~~11.   A method for adjusting~~ the data rate of data packets transiting a data network, the

2 system comprising:

3   determining a maximum data rate of data packet flow allowed through the data network;

4   monitoring the data rate of the data packets through the data network;

5   determining a predetermined priority of a data packet;

6   determining remaining memory in a memory circuit;

7   if the data packet has a low priority and the data rate is greater than the maximum data

8 rate, dropping the data packet; and

9   if the data packet has a high priority and the data rate is greater than the maximum data

10 ~~rate, processing the data packet.~~

1   12. The method of claim 11 and further including the steps of:

2   determining a minimum data rate of data packet flow allowed through the data network;

3 and

4   if the data rate is less than the minimum data rate, always processing the data packet.

1   13.   An apparatus for controlling the congestion of a buffer circuit, having a depth

2 indication signal, in a data network, the apparatus comprising:

3   the data monitor coupled to the data network input and accepting a stream of data

4 packets, the data rate monitor outputting the stream of data packets and a control signal

5 indicating the service flow's data packet flow rate;

6   a flow limiter having a data input coupled to the stream of data packets output from the

7 data rate monitor, the flow limiter also having a control input coupled to the control signal from

8 the data rate monitor, the flow limiter outputting the stream of data packets; and

9   a congestion controller having a data input coupled to the stream of data packets from the

10   flow limiter, the congestion controller also having a first control input coupled to the control

11   signal from the data rate monitor, a second control input coupled to the depth indication signal,

12   and a third control input coupled to a priority signal, the congestion controller controlling the rate

13   at which the stream of data packets enters the buffer circuit in response to the first, second, and

14   third control signals by dropping predetermined data packets from the stream of data packets.

1   14.   The apparatus of claim 13 wherein the flow limiter further includes a limiting

2   type control input for selectively changing an allowed data packet flow rate.

1   15.   The apparatus of claim 13 wherein the data rate monitor is coupled to a plurality

2   of cable modems.

1   16.   A cable modem interface for interfacing a cable modem termination system to a

2   plurality of cable modems, the cable modem termination system having a buffer circuit for

3   temporarily storing input data, the buffer circuit having a buffer depth indication signal that

4   indicates a depth of the buffer circuit, the interface comprising:

5   a downstream data path having a data stream input and a modulated output, the

6   downstream data path comprising:

7   a first data throughput monitor coupled to the data stream input, the first data

8   throughput monitor tracking a data rate of the data stream through the first data

9   throughput monitor and generating a first data rate signal in response to the tracked data

10   rate;

11   a first flow limiter, coupled to the first data throughput monitor, for limiting the

12   data rate of the data stream, the flow limiter having a control input coupled to the first

13   data rate signal; and

14   a modulator, coupled to the first flow limiter, for modulating the data stream for

15   transmission to the plurality of cable modems; and

16   an upstream data path comprising:

17   a demodulator, coupled to the plurality of cable modems, for demodulating an

18   input modulated signal into an input data bit stream comprising a plurality of packets;

19   a second data throughput monitor for monitoring a data flow rate of the input data

20   bit stream and generating a second data rate signal;

21   a second flow limiter, coupled to the second data throughput monitor, for limiting

22   the data flow rate of the input data bit stream, the second flow limiter coupled to the

23   second data rate signal;

24   a congestion controller, coupled to the second flow limiter, the congestion

25   controller having a plurality of control inputs, a first control input coupled to the buffer

26   depth indication signal, a second control input coupled to the second data rate signal, and

27   a third control input coupled to a priority signal indicating a priority of a group of

28   packets, the congestion controller controlling the number of packets entering the buffer

29   circuit in response to the plurality of control inputs.

1   17.   The cable modem interface of claim 16 and further including a limiting type input

2   to the first flow limiter for determining adherence of the cable modem interface to a set of cable

3   modem rules.

18.   The cable modem interface of claim 16 and further including a limiting type input

to the second flow limiter for determining adherence of the cable modem interface to a set of

cable modem rules.

19.   A method for a cable modem to communicate with a cable modem termination

system, the cable modem being assigned a predetermined service level, the cable modem

termination system comprising a buffer circuit for temporarily storing data packets, the method

comprising the steps of:

        the cable modem and the cable modem termination system performing a ranging step to

determine a channel and power level for communication that is acceptable to the cable modem

termination system;

        the cable modem registering with the cable modem termination system;

        the cable modem requesting additional bandwidth beyond the predetermined service

level;

        communicating data packets from the cable modem to the cable modem termination

system;

        determining a priority of the data packets;

        determining an average depth of the buffer circuit;

        determining a service flow associated with the data packets;

        determining a flow rate of the service flow associated with the data packets; and

        processing the data packets in response to the average depth of the buffer circuit, the flow

rate, and the priority.

20.   The method of claim 19 wherein the step of processing includes dropping packets

in response to the average depth of the buffer circuit, the flow rate, and the priority.

1   21.   The method of claim 19 wherein the step of registering includes the cable modem

2   termination system assigning an Internet protocol address to the cable modem.

1   22.   A cable modem comprising:

2   a buffer circuit comprising:

3   a buffer depth indication signal that indicates the amount of memory not being

4   used;

5   a cable modem interface comprising:

6   a plurality of data rate monitors, a first monitor for monitoring a data packet flow

7   rate in an upstream path and a second monitor for monitoring the data packet flow rate in

8   a downstream path, each monitor generating a flow rate indication signal;

9   a plurality of flow limiters, a first flow limiter, coupled to the first data rate

10   monitor, limiting the flow rate in the upstream path and a second flow limiter, coupled to

11   the second data rate monitor, limiting the flow rate in the downstream path, both flow

12   limiters acting in response to the respective flow rate indication signal; and

13   a congestion controller, coupled to the first flow limiter, for controlling the flow

14   of data into the buffer circuit in response to the flow rate indication signal, the buffer

15   depth indication signal, and a packet priority signal generated from the data packets; and

16   an Ethernet interface comprising:

17   a data rate monitor, coupled to the Internet, for monitoring the data packet flow

18   rate in the downstream path, the data rate monitor generating a flow rate indication

19   signal;

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20   a flow limiter, coupled to the data rate monitor, for limiting the flow rate in the

21   downstream path, the flow limiter acting in response to the flow rate indication signal;

22   and

23   a congestion controller, coupled to the flow limiter, for controlling the data

24   packets flowing into the buffer circuit in response to the flow rate indication signal, the

25   buffer depth indication signal, and a packet priority signal generated from the data

26   packets.